Ultra-Wideband Technology Testbed

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Ultra-wideband (UWB) systems emit extremely short electromagnetic pulses, where the pulse duration can range from tens of ps to 1 ns, corresponding to a spatial pulse width of 3 mm to 30 cm. Since the energy of the pulse is distributed across several GHz, the power spectral density is much lower in magnitude than a narrowband system. To a narrowband system, UWB signals appear below the noise floor, and are therefore very difficult to detect (Fig. 1). These characteristics, including their propagation through harsh multipath environments, enable the technology to be used in a wide range of applications from sensing to imaging to communications.

Project Goals

Our goal was to establish a uniform UWB testbed so that an accurate, repeatable, streamlined characterization of UWB RF components could be carried out in support of LLNL efforts.

Relevance to LLNL Mission

LLNL has been a pioneer in UWB technologies, ranging from Micropower Impulse Radar (MIR) to Transmit-Reference Communication (TRC) systems. Many of our programs have a need to characterize RF propagation.

FY2006 Accomplishments and Results

In FY2006, UWB systems were used for many LLNL projects and programs: to trigger active armor defense systems, measure extreme particle velocities, begin investigation into interior building visualization, track intrusions for cargo container security, and communicate in harsh urban and nautical environments.

All these activities have one thing in common, the need to characterize the RF propagation of existing and future

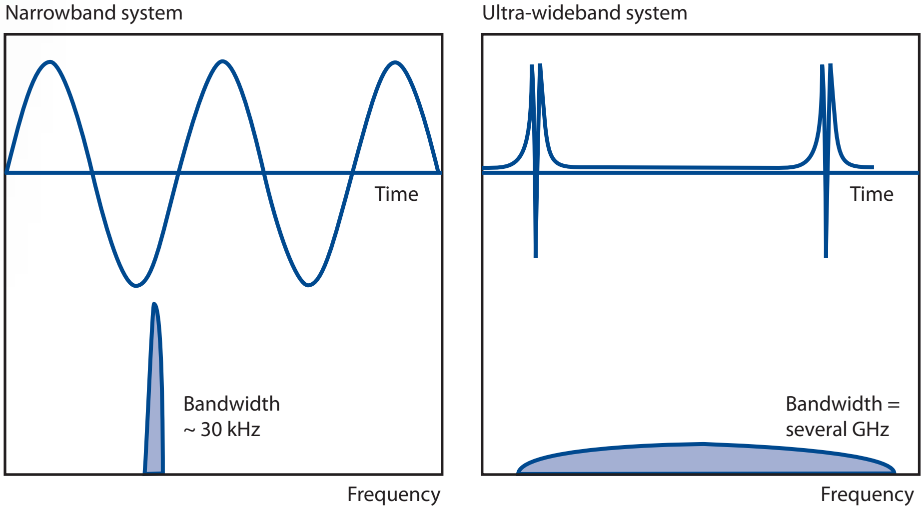

Figure 1. Narrowband vs. UWB in time and frequency domains.

systems. Of particular interest were antenna characterization (beam pattern, gain); transmitter characterization (pulse shape, bandwidth, noise floor); receiver characterization (bandwidth, noise floor); channel capacity; low probability of intercept and detection (LPI/D); resistance to jamming; performance in multipath channels; material penetration characteristics; and propagation physics.

As a result of this effort, a UWB test bed now exists at LLNL that can meet these needs.

Our UWB testbed room has been retrofitted so that radar absorbent material now lines the walls to produce a partial anechoic effect (Fig.2). A highly accurate, 3-axis gantry system permits reliable and repeatable experiments along the length and width of the room. This system is coupled with custom software to permit easy specification of trajectory paths, both by scripts and a drawing board (Fig.3). Test equipment such as oscilloscopes, spectrum analyzers, network analyzers, digitizers, and interval counters, has been consolidated into one location, along with LabView code to create a repository for data acquisition and storing. A database has been established and populated with the RF characterization of several standard UWB configured systems. A series of radar cross-section (RCS) targets have been acquired and manufactured to provide baseline performance information. Protocols are in place for ongoing and future characterization efforts.

This facility is available for use in RF characterization where a full anechoic chamber is not necessary. It is currently supporting a variety of projects.

Figure 2. UWB testbed built to produce a partial anechoic effect.

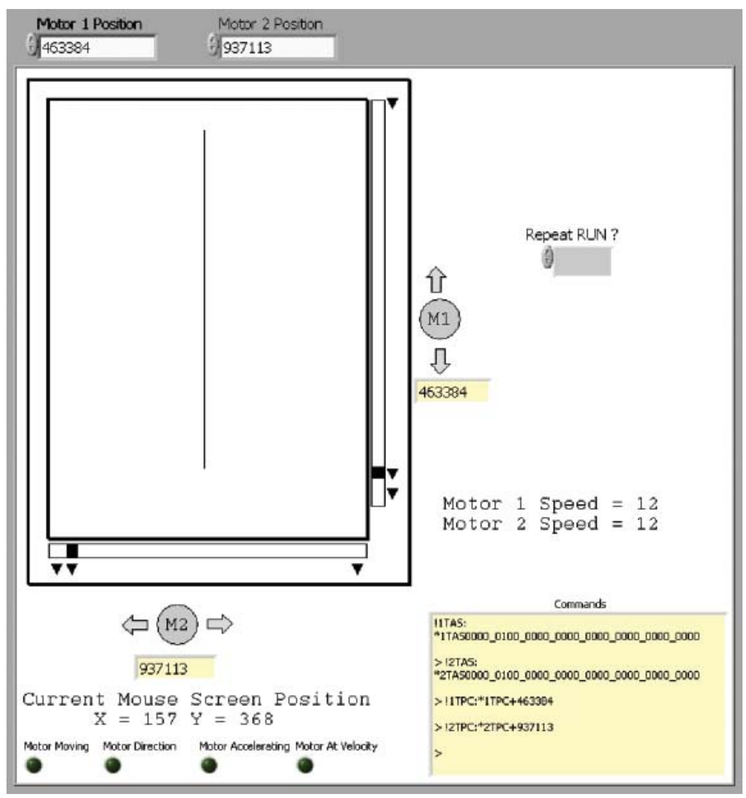

Figure 3. Three-axis gantry software graphical user interface.